

CLAIMS

1. A circular knitting machine, comprising a footing that supports a needle cylinder (2) that can be rotationally actuated, with respect to said footing about its own axis (2a), which is orientated substantially vertically; a plurality of axial slots (3) being formed on the outer lateral surface of the needle cylinder (2), each slot (3) accommodating a needle (4); means (7,8,9,10) for actuating the needles (4) being provided and interacting with said needles (4) during the rotation of the needle cylinder (2) about its own axis (2a) in order to actuate the needles (4) along the corresponding axial slot (3) of the needle cylinder (2) so that the needles (4) form knitting with at least one yarn dispensed to the needles (4) at at least one drop or feed (5) of the machine, characterized in that said needle actuation means comprise, for each needle, a sub-needle (7) arranged in the corresponding axial slot (3) of the needle cylinder (2) below the corresponding needle (4); said sub-needle (7) being connected bilaterally to the corresponding needle (4) in its motion along the corresponding axial slot (3) and having, along its extension, a heel (7a) that is orientated radially with respect to the needle cylinder (2); said sub-needle (7) being able to oscillate on a radial plane of the needle cylinder (2) in order to pass from an active position, in which the sub-needle (7) is extracted radially with its heel (7a) from the corresponding axial slot (3) of the needle cylinder (2) so as to engage paths formed by sub-needle actuation cams (8), which are arranged around the needle cylinder (2) and are suitable to produce or allow a movement of said sub-needle (7) along the corresponding axial slot (3) of the needle cylinder (2), to an inactive position, in which it is embedded with its heel (7a) in the corresponding axial slot (3) of the needle cylinder (2) so as to avoid engaging said sub-needle actuation cams (8); sub-needle actuation means (10) being provided which act on said sub-needle (7) for its transition from said active position to said inactive position and vice versa.

2. The machine according to claim 1, characterized in that said needle

has, along its extension, a heel that protrudes radially with respect to the needle cylinder and can engage paths formed by needle actuation cams that are arranged around the needle cylinder and are suitable to produce or allow movement of the needle along the corresponding axial slot of the needle cylinder.

3. The machine according to claim 1, characterized in that said means for actuating the sub-needle comprise an actuation element that is arranged in each one of said axial slots below the corresponding sub-needle and can move on command along the corresponding axial slot in order to interact with the lower end of the sub-needle and produce the transition and retention of said sub-needle in said active position or in said inactive position.

4. The machine according to one or more of the preceding claims, characterized in that said actuation element comprises an oscillating selector, which is provided, along its extension, with at least one heel that protrudes radially with respect to the needle cylinder, said selector being able to oscillate on a radial plane with respect to the needle cylinder in order to pass from an active position, in which it protrudes radially with its heel from the needle cylinder so as to engage paths defined by selector actuation cams arranged around the needle cylinder and suitable to produce or allow a movement of the selector along the corresponding axial slot of the needle cylinder, to an inactive position, in which it is embedded with its heel in the corresponding axial slot of the needle cylinder so as to avoid engaging said selector actuation cams, and vice versa, at least one selection device that acts on command on said selector for its transition or retention in said active position or in said inactive position being provided for each one of said drops or feeds.

5. The machine according to one or more of the preceding claims, characterized in that said needle cylinder can be actuated with a rotary motion about its own axis in both directions of rotation, and in that said

needle actuation means are suitable to allow the needles to form knitting in both directions of rotation of the needle cylinder about its own axis, at at least one drop or feed of the machine.

6. The machine according to one or more of the preceding claims, characterized in that said needle cylinder can be actuated with an alternating rotary motion about its own axis.

7. The machine according to one or more of the preceding claims, characterized in that for each one of said drops or feeds four selection devices are provided, two for each direction of rotation of the needle cylinder about its own axis, said devices acting on command on said selector for its transition or retention in said active position or in said inactive position.

8. The machine according to one or more of the preceding claims, characterized in that the lower end of said sub-needle is shaped complementarily to the upper end of said actuation element in order to move said sub-needle from said inactive position to said active position or vice versa as a consequence of an axial movement of said actuation element along the corresponding axial slot of the needle cylinder.

9. The machine according to one or more of the preceding claims, characterized in that the lower end of said sub-needle is forked, with a first prong that protrudes downward with respect to the second prong; said first prong lying closer to the bottom of the corresponding axial slot of the needle cylinder than said second prong; said first prong being engageable by an upper portion of said actuation element to move or stably retain said sub-needle in its inactive position, and said second prong being engageable by said upper portion of said actuation element to move or stably retain said sub-needle in the active position.

10. The machine according to one or more of the preceding claims, characterized in that said upper portion of said actuation element can be inserted, in the motion of said actuation element along the corresponding

axial slot of the needle cylinder, between the two prongs of the fork of the lower end of said sub-needle.

11. The machine according to one or more of the preceding claims, characterized in that said upper portion of said actuation element has, in a region that is spaced from the upper end of said upper portion, a first region that forms an inclined plane with respect to the longitudinal extension of the corresponding axial slot of the needle cylinder and can engage a corresponding region that forms an inclined plane and is provided at the lower end of said first prong of the fork of the sub-needle for the transition of said sub-needle from said active position to said inactive position as a consequence of the downward movement of said actuation element along the corresponding axial slot of the needle cylinder.

12. The machine according to one or more of the preceding claims, characterized in that the upper portion of said actuation element has, at its upper end, a second region that forms an inclined plane with respect to the longitudinal extension of the corresponding axial slot of the needle cylinder and can engage a corresponding region that forms an inclined plane and is provided at the lower end of said second prong of the fork of the sub-needle for the transition of said sub-needle from said inactive position to said active position as a consequence of the upward movement of said actuation element along the corresponding axial slot of the needle cylinder.

13. The machine according to one or more of the preceding claims, characterized in that said actuation element comprises, in addition to said selector, a pusher that is accommodated so that it can slide in the corresponding axial slot of the needle cylinder between said selector and said sub-needle, said upper portion of the actuation element that can engage the lower end of said sub-needle being constituted by the upper portion of said pusher.

14. The machine according to one or more of the preceding claims, characterized in that said pusher has, along its extension, a heel that

protrudes from the corresponding axial slot of the needle cylinder and can engage paths that are defined by pusher actuation cams arranged around the outer lateral surface of the needle cylinder and are shaped so as to produce a motion of said pushers along the corresponding axial slots of the needle cylinder.

15. The machine according to one or more of the preceding claims, characterized in that said sub-needle actuation cams comprise lowering cams to produce the downward movement of the needles after engaging the yarn at each one of said drops or feeds.

16. The machine according to one or more of the preceding claims, characterized in that the paths defined by said selector actuation cams have, ahead of each drop or feed, a first rising portion and a second rising portion whose peak is higher than the peak of said first rising portion for the upward movement of the needles respectively to a tuck-stitch lifting level and to a drop-stitch lifting level for the overlying needle, at least one selection device being interposed between said first rising portion and said second rising portion.

17. The machine according to one or more of the preceding claims, characterized in that two selection devices are arranged sequentially between said first rising portion and said second rising portion of the selector actuation cams and can be used selectively depending on the direction of rotation of the needle cylinder about its own axis.

18. The machine according to one or more of the preceding claims, characterized in that the bottom of each axial slot of the needle cylinder has a portion that can be engaged by said sub-needle at least in its fully lifted condition in order to retain said sub-needle in its active position.

19. The machine according to one or more of the preceding claims, characterized in that said selection devices are arranged at a same height.

20. The machine according to one or more of the preceding claims, characterized in that it comprises four drops or feeds, which are angularly

mutually spaced around the axis of the needle cylinder.

21. The machine according to one or more of the preceding claims, characterized in that said needle actuation means are suitable to allow the needles to form knitting in both directions of rotation of the needle cylinder about its own axis at each one of the drops or feeds.

22. The machine according to one or more of the preceding claims, characterized in that said needle actuation cams, said sub-needle actuation cams, said pusher actuation cams and said selector actuation cams have configurations and arrangements that are symmetrical with respect to a radial plane of the needle cylinder that passes through a drop or feed.

23. The machine according to one or more of the preceding claims, characterized in that said selection devices are arranged symmetrically with respect to a radial plane of the needle cylinder that passes through a drop or feed.

24. The machine according to one or more of the preceding claims, characterized in that said needle cylinder has a diameter that is substantially comprised between 7 and 24 inches.